

Recommended books:

Prescott, Harley, and Klein's Microbiology, 5th edition.

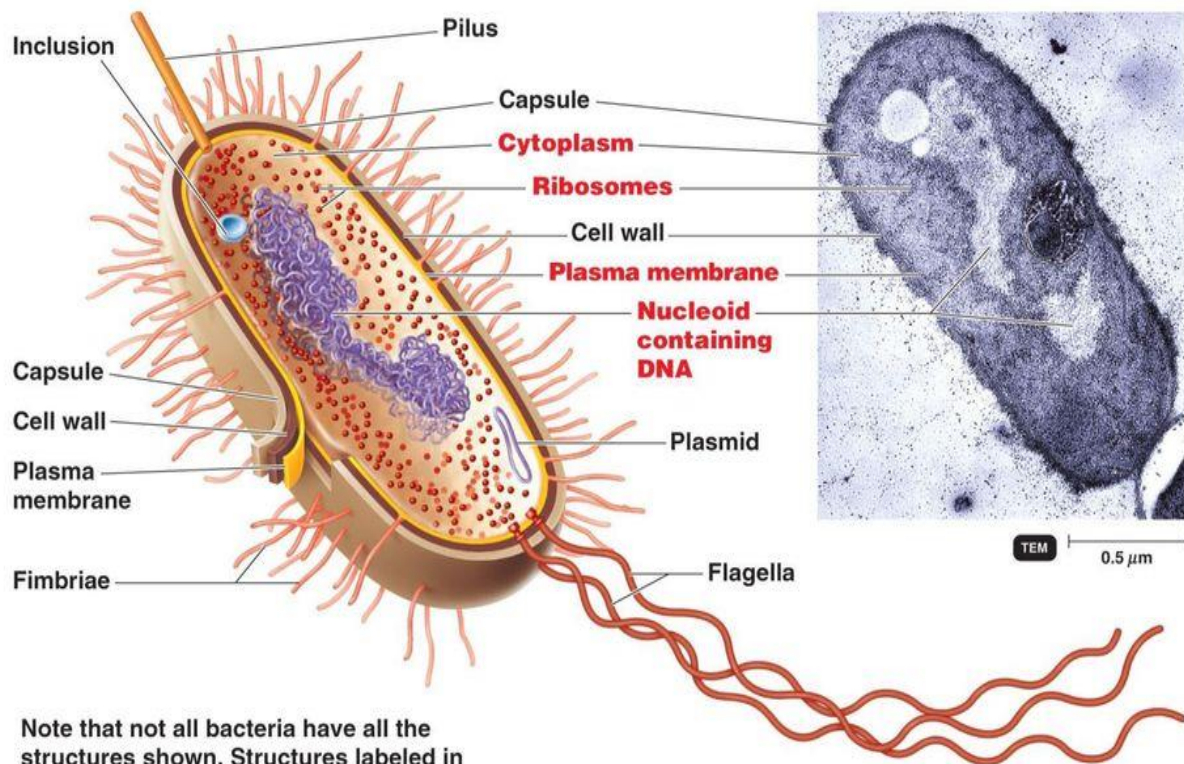
Microbiology by **Pelczar**.

Alcamo's fundamentals of microbiology.

Bacterial Cell:

Bacterial cells are different from plant & animal cells. Bacteria are prokaryotes.

Typical Bacterial Cell (Prokaryotic)



Note that not all bacteria have all the structures shown. Structures labeled in **red** are found in all bacteria. Both the drawing and the micrograph show a bacterium sectioned lengthwise to reveal the internal composition.

Key Concept

Prokaryotic cells lack membrane-enclosed organelles. All bacteria contain cytoplasm, ribosomes, a plasma membrane, and a nucleoid. Almost all bacteria have cell walls.

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Capsule: A layer found on the outside of the cell wall in some bacteria. It is a polysaccharide layer that lies outside the cell envelope and is thus deemed part of the outer envelope of a bacterial cell. It is a well-organized layer, not easily washed off, and it can be the cause of various diseases. It has several functions: promote bacterial adhesion to surfaces or interaction with other organisms; act as a permeability barrier, as a defense mechanism against phagocytosis and/or as a nutrient reserve. Among pathogens, capsule formation often correlates with pathogenicity. Capsules are formed by organisms such as *Klebsiella pneumoniae*.

Cell wall: A layer that is made of a polymer called peptidoglycan. Peptidoglycan is a rigid, highly conserved, complex structure of polymeric carbohydrates and amino acids. The cell wall gives the bacteria its shape and it is a protective barrier. It is located outside the plasma membrane. The cell wall is thicker in some bacteria, called Gram positive bacteria.

Plasma membrane: It is found within the cell wall; this generates energy and transports chemicals. The membrane is permeable, which means that substances can pass through it. It is composed of 40 percent phospholipid and 60 percent protein. The phospholipids are amphiphilic molecules with a polar hydrophilic glycerol "head" attached via an ester bond to two nonpolar hydrophobic fatty acid tails, which naturally form a bilayer in aqueous environments.

Cytoplasm: The cytoplasm, or protoplasm, of bacterial cells is where the functions for cell growth, metabolism, and replication are carried out. It is a gelatinous substance (gel like matrix) inside the plasma membrane composed of water, enzymes, nutrients, wastes, and gases and contains genetic material and cell structures (ribosomes, a chromosome, and plasmids).

DNA: In many bacteria the DNA is present as a single circular chromosome. This contains all the genetic instructions used in the development and function of the bacterium. It is located inside the cytoplasm. bacterial DNA contains the four nitrogenous bases adenine (A), cytosine (C), guanine (G), and thymine (T). All of the DNA found in an organism is collectively referred to as the genome. Bacterial DNA is normally in equilibrium between a closed circular double-stranded state (relaxed) and a highly negatively supercoiled state.

Ribosomes: This is where proteins are made, or synthesized. Ribosomes are complex particles made up of RNA-rich granules. Bacteria have 70S ribosomes,

each consisting of a small (30S) and a large (50S) subunit. *E. coli*, for example, has a 16S RNA subunit (consisting of 1540 nucleotides) that is bound to 21 proteins. The large subunit is composed of a 5S RNA subunit (120 nucleotides), a 23S RNA subunit (2900 nucleotides) and 31 proteins.

Flagellum: This is used for movement, to propel some types of bacteria. There are some bacteria that can have more than one. Bacterial flagella are helically shaped structures containing the protein flagellin. The base of the flagellum (the hook) near the cell surface is attached to the basal body enclosed in the cell envelope. The flagellum rotates in a clockwise or counterclockwise direction, in a motion similar to that of a propeller.

Pili: These hair-like appendages (6-7 mm in diameter) on the outside of the cell allow it to stick to surfaces and transfer genetic material to other cells via the process of bacterial conjugation. Hence the conjugative pili allow for the transfer of DNA between bacteria. Therefore, they are sometimes called "sex pili", in analogy to sexual reproduction, because they allow for the exchange of genes via the formation of "mating pairs". This can contribute to the spread of illness in humans.

Inclusions and Granules:

Concentrated deposits of certain substances which are presented/located in the cytoplasm of certain bacteria are known as cytoplasmic granules/ storage granules or inclusion bodies. Cytoplasmic granules serve as storage areas for nutrients, e.g. volutin granules are reserves of high energy stored in the form of polymerized metaphosphate. **Polysaccharide granules (glycogen):** a storage form of glucose, **polyphosphate granules:** a storage form for inorganic phosphates (volutin granules, also known as metachromatic granules, are composed of polyphosphate), **poly- β -hydroxybutyrate (PHB) granules:** a reserve carbon and energy source; and **Elemental sulfur:** Intracellular globules of elemental sulfur may be seen accumulated in certain bacteria growing in environments rich in hydrogen sulfide. **Inclusion bodies** are nuclear or cytoplasmic aggregates of stainable substances, usually proteins. They typically represent sites of viral multiplication in a bacterium and usually consist of viral capsid proteins. When genes from one organism are expressed in another the resulting protein sometimes forms inclusion bodies.

Spore: Bacterial spores are one of the most resistant life forms known to date, being extremely tolerant against various stresses such as heat, chemicals, and harsh physical conditions. One of the signature properties of spores is heat resistance. An endospore is a dormant, tough, and non-reproductive structure produced by some bacteria. Spore-forming bacteria include *Bacillus* (aerobic) and *Clostridium* (anaerobic) species. The spores of these species are dormant bodies that carry all the genetic material as is found in the vegetative form, but do not have an active metabolism. The endospore consists of the bacterium's DNA, ribosomes and large amounts of dipicolinic acid. Dipicolinic acid is a spore-specific chemical that appears to help in the ability for endospores to maintain dormancy. Some classes of bacteria can turn into exospores, also known as microbial cysts, instead of endospores.

